

ticularly well-adapted agent for the working of such machinery. A modern book on cranes becomes thus quite naturally a book on electric cranes.

Mr. Hill's work is a thoroughly practical treatise on electric crane construction. The subject is so complicated and so many-sided that any attempt to treat it in a general way must be unsatisfactory, and the author has wisely decided to represent his subject rather by means of well-chosen examples of successful work than by a general treatise. The importance of scientific principles is, however, not overlooked; interleaved with the descriptive matter we find the necessary calculations as to stresses, stability, power required, action of brakes, and other matters capable of scientific treatment. The examples chosen comprise various forms of overhead travelling cranes, locomotive and portable jib cranes, derricks, sheer legs, transporters, revolving cantilever cranes, and cableways. Then follows a chapter on the power required for crane driving. From tests quoted by the author, it appears that the efficiency in many cases is remarkably high, reaching nearly 70 per cent.

In discussing starting torque and acceleration, the author also quotes from practical experience for hoisting, lowering, travelling, and slewing. Chapter x. deals with the design of crane structures. Here we find discussed the strength of struts, both on the basis of Euler's and Rankine's formulæ, the strength of lattice girders and various types of beams generally, the construction of cantilevers and cognate matters, all exemplified by very full diagrams and working drawings.

The following three chapters deal with design of machinery, frames, bearings, axles, and drums, brakes and toothed gear. Especially the last-named subject is very fully treated, including the question of permissible wear and the use of worm-gearing. Most readers will be surprised at the high efficiency obtained by this mode of driving, when the worm runs in an oil bath. The explanation given by the author is that metallic contact between the teeth does not take place, since the film of oil between the surfaces is not squeezed out even at very heavy pressure. This has also been the experience of motor-car designers who find for worm-drive efficiencies well above 90 per cent.

After a short chapter on hooks, ropes, and chains, we come to the electric and magnetic details beginning with the design of magnets. It is to be regretted that the author has adopted the hybrid system of units where induction is given as so many c.g.s. lines per square inch. In working with such a system one loses completely the connection with first principles, and the solution of any problem becomes simply a matter of blindly applying certain formulæ. As regards motors, the author deals very fully with the question of rating as influenced by the intermittent service, and he shows that crane motors should, as regards mechanical strength and commutation, be designed for the full load, but as regards heating for a very much reduced load. Only D.C. motors are discussed, the author holding that A.C. motors are unsuitable for crane work. This is perhaps too sweeping a condemnation. In many docks on the Continent

polyphase motors are used, and with the advent of the A.C. commutator motor there is given every facility for using alternating current where no continuous current is available, and the author's recommendation of installing a converter for the power supply to the cranes becomes a useless complication.

A table on p. 302, giving from practical experience the annual working cost of seven different cranes, is very interesting. It shows that the cost of power taken at 1.5d. per unit is negligibly small. It amounts in the worst case to only 1.3 per cent. of the total cost, and in most cases it is about 1 per cent. Thus, with current purchased even at the usual lighting rate of about 4d. per unit, the cost of power is quite insignificant. This is due to the fact that the load factor of a crane is exceedingly small. The total energy given off by all the crane motors per annum only represents full output over about twenty to seventy hours per annum. The annual cost is almost entirely made up by interest, depreciation, and repairs, and the problem to be solved by the designer of cranes is not so much the saving of current as the production of a cheap and robust design.

GISBERT KAPP.

MORPHOLOGY OF THE VERTEBRATES.

Éléments de Morphologie des Vertébrés. Anatomie et Embryologie Comparées, Paléontologie et Classification. By Prof. L. Vialleton. Pp. xiv+790. (Paris: Octave Doin et Fils, 1911.) Price 18 francs.

THIS is an interesting and thoughtful introduction to the morphology of the vertebrata, very clearly written, well illustrated, and with several distinctive features. The author thinks, probably with justice, that the vertebrata are better subjects than the invertebrates for the illustration of morphological principles. Their structure is more thoroughly known and its relations to the conditions of life are more certain; the development of the chief types has been worked out in its main features; and we have, on the whole, more information in regard to the past history. Filiation is clearer among vertebrates than among invertebrates. For learning the lessons of morphology it is better to begin with one phylum than with many, and the most educationally profitable phylum is that with which students are likely to be most familiar—the vertebrata.

The plan of the book is as follows. After an introduction dealing with general concepts such as homology, the author devotes the first part to general embryology—the germinal layers, the early primordia, and the fundamental architecture of head and trunk and limbs. The second part deals seriatim with all the systems and organs, from the skin to the gonads, treating everything comparatively and embryologically. It is all very clear and careful, but in a book of the dimensions of this one we look for rather more criticism. To take but a single instance, we think Vialleton's conventional account of the pectoral skeleton of the Monotreme, with its episternum and absence of procoracoids, might have been improved without risk of dogmatism. We may notice here that

there is a carefully selected bibliography at the end of each chapter, and that the references are punctiliously accurate.

The third part of the book gives a systematic account of the whole phylum of vertebrates, and takes due notice of the extinct forms. There are many interesting detailed expressions of the author's judgment, *e.g.* his treatment of the Ratitæ as a heterogeneous group derivable from at least three stocks, or his reuniting of Marsupials with Eutheria; but the outstanding feature in this section is to be found in the numerous carefully drawn up schemata showing distribution in time and probable affinities. There are twenty of these, condensing much reflection.

In the concluding section of his book, Prof. Vialleton deals analytically with the problem of the evolution of vertebrates. He discusses the origin of organs, and makes much of Kleinenberg's theory of substitution; he distinguishes between well-established genetic series and morphological series (so often mixed up together, *e.g.* in connection with the evolution of Equidæ); he recognises the importance of paying more attention to the phenomena of convergence; he gives an admirable discussion of correlation and of vestigial organs. Passing to the actual data bearing on the phylogeny of vertebrates, he marshals the palæontological facts in a masterly way, and discusses such points as the successive appearance of classes, the occurrence of generalised types and transitional types, the absence of the latter at phyletic bifurcations, the extinction of types, and the indubitable progress from age to age. Turning to embryological data we find an admirable critical discussion of the recapitulation doctrine, of which there is little left when the author has done. We cannot help feeling, however, that there is sure to be a rebound in a few years to some subtler rehabilitation of Haeckel's famous biogenetic law. The author believes in a good deal of polyphyly, and he confesses himself a mutationist: *transformist* theories do not please him: "C'est l'évolution avec ses brusqueries et ses divergences qui constitue la réalité."

THE PRINCIPLE OF RELATIVITY.

Das Relativitätsprinzip. By Dr. M. Laue. Pp. x+208. (Braunschweig: F. Vieweg und Sohn, 1911.) Price 6.50 marks.

IT is almost impossible nowadays to glance through a journal containing original papers in physics without coming across something relating to the Principle of Relativity. This principle is an extension of that Newtonian relativity which enables us to treat machines on a moving earth as if they were at rest. The new extension covers the phenomena of optics, heat, and electromagnetism. It is sometimes called the electromagnetic principle of relativity, but as it contains also a mechanical principle it has now become usual to term it simply the Principle of Relativity. It asserts that physical phenomena generally do not depend upon rectilinear uniform translation through space; that, for instance, the optical isotropy of space is not affected by motion through it; that the velocity of light is the same in all directions and

independent of displacement; and that it is therefore impossible to discover, say, the earth's motion of translation by any optical, electrical, or mechanical device. In fact, it is based upon the negative result of the Michelson-Morley experiment, and all other attempts to discover "aether-drift."

Einstein, who founded the modern relativity theory in 1905, based his arguments upon the impossibility of establishing an absolute time-scale, either as regards rate or as regards epoch, so long as the utmost limit of rapidity of signalling is imposed by the finite velocity of light. He showed how this limitation affects all measurements of length and time whenever the relative velocity dealt with approaches the velocity of light. The clocks in a moving system, synchronised by light signals, necessarily have a slower rate than those in a system at rest, in the ratio $\sqrt{1 - \frac{v^2}{c^2}} : 1$, where v is the relative velocity and c the velocity of light, and this applies whichever of two systems is regarded as being at rest. There is, in fact, no "absolute" time-scale.

Many conclusions from this principle appear far-fetched, even fantastic. Thus, not only electrons, but all matter possesses an infinite "mass" when moving with the velocity of light; mass is identical with latent energy; two particles projected in opposite directions with the velocity of light have a "relative" velocity which simply equals the velocity of light, and so on. In spite of such apparent absurdities, the Principle of Relativity has made what is no less than a triumphal march through the world's physical publications.

Dr. Laue's work comes, therefore, as a welcome contribution to what has become a matter of very living interest. He goes fully into the negative results of Michelson, Trouton, Brace, Rayleigh, and others, the positive results of Wilson, Rowland, Eichenwald, Lebedew, Poynting (misspelt "Pointing"), and Fizeau, and the theoretical work of Lorentz, Einstein, and Minkowski. He shows that there is no physical evidence against the principle, and that it has the advantage over other systems of accounting for the absence of aether-drift. In the analytical work, a vector algebra on the basis of Heaviside's notation is used, but it is made, after Minkowski's example, four-dimensional. A brief summary of operations with these "world-vectors" is of great assistance to the reader.

E. E. F.

OUR BOOK SHELF.

The Principles of Electric Wave Telegraphy and Telephony. By Prof. J. A. Fleming, F.R.S. Second edition (revised and extended). Pp. xx+906. (London: Longmans, Green and Co., 1910.) Price 28s. net.

WHEN reviewing the first edition of Prof. Fleming's book five years ago we pointed out that it filled to perfection the want for a thorough and exhaustive treatise on the subject of wireless telegraphy, and was sure of a warm welcome on that account. Since then the volume has been twice reprinted, and now there is issued a new edition largely rewritten and considerably improved. The rapid pro-